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ACTION OF AN INTERMITTENT BEAM OF RADIANT HEAT UPON GASEOUS MATTER.

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UNDER the above title the following important paper, relating to photophonic phenomena, has been printed for the Proceedings of the Royal Society :—

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The Royal Society has already done me the honour of publishing a long series of memoirs on the interaction of radiant heat and gaseous matter. These memoirs did not escape criticism. Distinguished men, among whom the late Professor Magnus and the late Professor Buff may be more specially mentioned, examined my experiments, and arrived at results different from mine. Living workers of merit have also taken up the question: the latest of whom,* while justly recognising the extreme difficulty of the subject, and while verifying, so far as their experiments reach, what I had published regarding dry gases, find me to have fallen into what they consider grave errors in my treatment of vapours.

None of these investigators appear to me to have realised the true strength of my position in its relation to the objects I had in view. Occupied for the most part with details, they have failed to recognise the stringency of my work as a whole, and have not taken into account the independent support rendered by the various parts of the investigation to each other. They thus ignore verifications, both general and special, which are to me of conclusive force. Nevertheless, thinking it due to them and me to submit the questions at issue to a fresh examination, I resumed, some time ago, the threads of the inquiry. The results shall, in due time, be communicated to the Royal Society; but, meanwhile, I would ask permission to bring to the notice of the Fellows a novel mode of testing the relations of radiant heat to gaseous matter, whereby singularly instructive effects have been obtained.

After working for some time with the thermopile and galvanometer, it occurred to me several weeks ago that the results thus obtained might be checked by a more direct and simple form of experiment. Placing the gases and vapours in diathermanous bulbs, and exposing the bulbs to the action of radiant heat, the heat absorbed by different gases and vapours ought, I considered, to be rendered evident by ordinary expansion. I devised an apparatus with a view of testing this idea. But, at this point, and before my proposed gas thermometer was constructed, I became acquainted with the ingenious and original experiments of Mr. Graham Bell, wherein musical sounds are obtained through the action of an intermittent beam of light upon solid bodies.

From the first, I entertained the opinion that these singular sounds were caused by rapid changes of temperature, producing corresponding changes of shape and volume in the bodies impinged upon by the beam. But if this be the case, and if gases and vapours really absorb radiant heat, they ought to produce sounds more intense than those obtainable from solids. I pictured every stroke of the beam responded to by a sudden expansion of the absorbent gas, and concluded that when the pulses thus excited followed each other with sufficient rapidity, a musical note must be the result. It seemed plain, moreover, that by this new method many of my previous results might be brought to an independent test. Highly diathermanous bodies, I reasoned, would produce faint sounds; while highly athermanous bodies would produce loud sounds; the strength of the sound being, in a sense, a measure of the absorption. The first experiment made, with a view of testing this idea, was executed in the presence of Mr. Graham Bell;* and the result was in exact accordance with what I had foreseen.

The inquiry has been recently extended so as to embrace most of the gases and vapours employed in my former researches. My first source of rays was a Siemens' lamp connected with a dynamo machine, worked by a gas engine. A glass lens was used to concentrate the rays, and afterwards two lenses. By the first the rays were rendered parallel, while the second caused them to converge to a point about 7 inches distant from the lens. A circle of sheet zinc provided first with radial slits and afterwards with teeth and interspaces, cut through it, was mounted vertically on a whirling table, and caused to rotate rapidly across the beam near the focus. The passage of the slits produced the desired intermittence,† while a flask containing the gas or vapour to be examined received the shocks of the beam immediately behind the rotating disc. From the flask a tube of india-rubber, ending in a tapering one of ivory or box wood, led to the ear, which was thus rendered keenly sensitive to any sound generated within the flask. Compared with the beautiful apparatus of Mr. Graham Bell, the arrangement here described is rude; it is, however, effective.

* MM. Lecher and Pernter, "Philosophical Magazine," January, 1881. "Sitzb. der K. Akad. der Wissensch. in Wien," July, 1880.

* On the 29th November: see "Journal of the Society of Telegraph Engineers," December 8, 1880.

† When the disc rotates the individual slits disappear, forming a hazy zone through which objects are visible. Throwing by the clean hand, or better still by white paper, the beam back upon the disc, it appears to stand still, the slits forming so many dark rectangles. The reason is obvious, but the experiment is a very beautiful one.

I may add that when I stand with open eyes in the flashing beam, at a definite velocity of recurrence, subjective colours of extraordinary gorgeousness are produced. With slower or quicker rates of rotation the colours disappear. The flashes also produce a giddiness, sometimes intense enough to cause me to grasp the table to keep myself erect.

With this arrangement the number of sounding gases and vapours was rapidly increased. But I was soon made aware that the glass lenses withdrew from the beam its effectual rays. The silvered mirrors employed in my previous researches were therefore invoked; and with them, acting sometimes singly and sometimes as conjugate mirrors, the curious and striking results which I have now the honour to submit to the Society were obtained.

Sulphuric ether, formic ether, and acetic ether being placed in bulbous flasks,* their vapours were soon diffused in the air above the liquid. On placing these flasks, whose bottoms only were covered by the liquid, behind the rotating disc, so that the intermittent beam passed through the vapour, loud musical tones were in each case obtained. These are known to be the most highly absorbent vapours which my experiments revealed. Chloroform and bisulphide of carbon, on the other hand, are known to be the least absorbent, the latter standing near the head of diathermanous vapours. The sounds extracted from these two substances were usually weak and sometimes barely audible, being more feeble with the bisulphide than with the chloroform. With regard to the vapours of amylene, iodide of ethyl, iodide of methyl and benzol, other things being equal, their power to produce musical tones appeared to be accurately expressed by their ability to absorb radiant heat.

It is the vapour, and not the liquid, that is effective in producing the sounds. Taking, for example, the bottles in which my volatile substances are habitually kept, I permitted the intermittent beam to impinge upon the liquid in each of them. No sound was in any case produced, while the moment the vapour-laden space above an active liquid was traversed by the beam, musical tones made themselves audible.

A rock-salt cell filled entirely with a volatile liquid, and subjected to the intermittent beam, produced no sound. This cell was circular and closed at the top. Once, while operating with a highly athermanous substance, a distinct musical note was heard. On examining the cell, however, a small bubble was found at its top. The bubble was less than a quarter of an inch in diameter, but still sufficient to produce audible sounds. When the cell was completely filled, the sounds disappeared.

It is hardly necessary to state that the pitch of the note obtained in each case is determined by the velocity of rotation. It is the same as that produced by blowing against the rotating disc and allowing its slits to act like the perforations of a syren.

Thus, as regards vapours, prevision has been justified by experiment. I now turn to gases. A small flask, after having been heated in the spirit-lamp so as to detach all moisture from its sides, was carefully filled with dried air. Placed in the intermittent beam it yielded a musical note, but so feeble as to be heard only with attention. Dry oxygen and hydrogen behaved like dry air. This agrees with my former experiments, which assigned a hardly sensible absorption to these gases. When the dry air was displaced by carbonic acid, the sound was far louder than that obtained from any of the elementary gases. When the carbonic acid was displaced by nitrous oxide, the sound was much more forcible still, and when the nitrous oxide was displaced by olefiant gas, it gave birth to a musical note which, when the beam was in good condition, and the bulb well chosen, seemed as loud as that of an ordinary organ pipe.* We have here the exact order in which my former experiments proved these gases to stand as absorbers of radiant heat. The amount of the absorption and the intensity of the sound go hand in hand.

A soap bubble blown with nitrous oxide, or olefiant gas, and exposed to the intermittent beam, produced no sound, no matter how its size might be varied. The pulses obviously expended themselves upon the flexible envelope, which transferred them to the air outside.

But a film thus impressionable to impulses on its interior surface, must prove at least equally sensible to sonorous waves impinging on it from without. Hence, I inferred, the eminent suitability of soap bubbles for sound lenses. Placing a "sensitive flame" some feet distant from a small sounding reed, the pressure was so arranged that the flame burnt tranquilly. A bubble of nitrous oxide (sp. gr. 1·527) was then blown, and placed in front of the reed. The flame immediately fell and roared, and continued agitated as long as the lens remained in position. A pendulous motion could be imparted to the bubble, so as to cause it to pass to and fro in front of the reed. The flame responded, by alternately roaring and becoming tranquil, to every swing of the bubble. Nitrous oxide is far better for this experiment than carbonic acid, which speedily ruins its envelope.

The pressure was altered so as to throw the flame, when the reed sounded, into violent agitation. A bubble blown with hydrogen (sp. gr. 0·069) being placed in front of the reed, the flame was immediately stilled. The ear answers instead of the flame.

In 1859 I proved gaseous ammonia to be extremely impervious to radiant heat. My interest in its deportment when subjected to this novel test was therefore great. Placing a small quantity of liquid ammonia in one of the flasks, and warming the liquid slightly, the intermittent beam was sent through the space above the liquid. A loud musical note was immediately produced. By the proper application of heat to a liquid the sounds may be always intensified. The ordinary temperature, however, suffices in all the cases thus far referred to.

In this relation the vapour of water was that which interested me most, and as I could not hope that at ordinary temperatures it existed in sufficient amount to produce audible tones, I heated a small quantity of water in a flask almost up to its boiling-point. Placed in the intermittent beam, I heard—I avow with delight—a powerful musical sound produced by the aqueous vapour.

Small wreaths of haze, produced by the partial condensation of the vapour in the upper and cooler air of the flask, were, however, visible in this experiment; and it was necessary to prove that this haze was not the cause of the sound. The flask was, therefore, heated by a spirit-flame beyond the temperature of boiling water. The closest scrutiny by a condensed beam of light then revealed no trace of cloudiness above the liquid. From the perfectly invisible vapour, however, the musical sound issued, if anything, more forcible than before. I placed the flask in cold water until its temperature was reduced from about 90° to 10° C., fully expecting that the sound would vanish at this temperature; but, notwithstanding the tenuity of the vapour, the sound extracted from it was not only distinct but loud.

Three empty flasks, filled with ordinary air, were placed in a freezing mixture for a quarter of an hour. On being rapidly transferred to the intermittent beam,

* I have employed flasks measuring from 8 inches to ⅛ths of an inch in diameter. The smallest flask, which had a stem with a bore of about ¼th of an inch in diameter, yielded better effects than the largest. Flasks from 2 to 3 inches in diameter yield good results. Ordinary test-tubes also answer well.

* With conjugate mirrors the sounds with olefiant gas are readil obtained at a distance of twenty yards from the lamp. I hope t be able to make a candle flame effective in these experiments.

sounds much louder than those obtainable from dry air were produced.

Warming these flasks in the flame of a spirit-lamp until all visible humidity had been removed, and afterwards urging dried air through them, on being placed in the intermittent beam the sound in each case was found to have fallen almost to silence.

Sending, by means of a glass tube, a puff of breath from the lungs into a dried flask, the power of emitting sound was immediately restored.

When, instead of breathing into a dry flask, the common air of the laboratory was urged through it, the sounds became immediately intensified. I was by no means prepared for the extraordinary delicacy of this new method of testing the athermancy and diathermancy of gases and vapours, and it cannot be otherwise than satisfactory to me to find that particular vapour, whose alleged deportment towards radiant heat has been most strenuously denied, affirming thus audibly its true character.

After what has been stated regarding aqueous vapour, we are prepared for the fact that an exceedingly small percentage of any highly athermanous gas diffused in air suffices to exalt the sounds. An accidental observation will illustrate this point. A flask was filled with coal-gas and held bottom upwards in the intermittent beam. The sounds produced were of a force corresponding to the known absorptive energy of coal-gas. The flask was then placed upright, with its mouth open upon a table, and permitted to remain there for nearly an hour. On being restored to the beam, the sounds produced were far louder than those which could be obtained from common air.

Transferring a small flask or a test-tube from a cold place to the intermittent beam, it is sometimes found to be practically silent for a moment, after which the sounds become distinctly audible. This I take to be due to the vaporisation by the calorific beam of the thin film of moisture adherent to the glass.

My previous experiments having satisfied me of the generality of the rule that volatile liquids and their vapours absorb the same rays, I thought it probable that the introduction of a thin layer of its liquid, even in the case of a most energetic vapour, would detach the effective rays, and thus quench the sounds. The experiment was made, and the conclusion verified. A layer of water, formic ether, sulphuric ether, or acetic ether, $\frac{1}{4}$th of an inch in thickness, rendered the transmitted beam powerless to produce any musical sound. These liquids being transparent to light, the efficient rays which they intercepted must have been those of obscure heat.

A layer of bisulphide of carbon about 10 times the thickness of the transparent layers just referred to, and rendered opaque to light by dissolved iodine, was interposed in the path of the intermittent beam. It produced hardly any diminution of the sounds of the more active vapours—a further proof that it is the invisible heat rays, to which the solution of iodine is so eminently transparent, that are here effectual.

Converting one of the small flasks used in the foregoing experiments into a thermometer bulb, and filling it with various gases in succession, it was found that with those gases which yielded a feeble sound, the displacement of a thermometric column associated with the bulb was slow and feeble, while with those gases which yielded loud sounds, the displacement was prompt and forcible.

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FURTHER EXPERIMENTS.

Since the handing in of the foregoing note, on the 3rd of January, the experiments have been pushed forward; augmented acquaintance with the subject serving only to confirm my estimate of its interest and importance.

All the results described in my first note have been obtained in a very energetic form with a battery of sixty Grove's cells.

On the 4th of January I chose for my source of rays a powerful lime-light, which, when sufficient care is taken to prevent the pitting of the cylinder, works with admirable steadiness and without any noise. I also changed my mirror for one of shorter focus, which permitted a nearer approach to the source of rays. Tested with this new reflector the stronger vapours rose remarkably in sounding power.

Improved manipulation was, I considered, sure to extract sounds from rays of much more moderate intensity than those of the lime-light. For this light, therefore, a common candle flame was substituted. Received and thrown back by the mirror, the radiant heat of the candle produced audible tones in all the stronger vapours.

Abandoning the mirror and bringing the candle close to the rotating disc, its direct rays produced audible sounds.

A red-hot coal, taken from the fire and held close to the rotating disc, produced forcible sounds in a flask at the other side.

A red-hot poker, placed in the position previously occupied by the coal, produced strong sounds. Maintaining the flask in position behind the rotating disc, amusing alternations of sound and silence accompanied the alternate introduction and removal of the poker.

The temperature of the iron was then lowered till its heat just ceased to be visible. The intermittent invisible rays produced audible sounds.

The temperature was gradually lowered, being accompanied by a gradual and continuous diminution of the sound. When it ceased to be audible the temperature of the poker was found to be below that of boiling water.

As might be expected from the foregoing experiments, an incandescent platinum spiral, with or without the mirror, produced musical sounds. When the battery power was reduced from ten cells to three, the sounds, though enfeebled, were still distinct.

My neglect of aqueous vapour had led me for a time astray in 1859, but before publishing my results I had discovered my error. On the present occasion this omnipresent substance had also to be reckoned with. Fourteen flasks of various sizes, with their bottoms covered with a little sulphuric acid, were closed with ordinary corks and permitted to remain in the laboratory from the 23rd of December to the 4th of January. Tested on the latter day with the intermittent beam, half of them emitted feeble sounds, but half were silent. The sounds were undoubtedly due, not to dry air, but to traces of aqueous vapour.

An ordinary bottle, containing sulphuric acid for laboratory purposes, being connected with the ear and placed in the intermittent beam, emitted a faint, but distinct, musical sound. This bottle had been opened two or three times during the day, its dryness being thus vitiated by the mixture of a small quantity of common air. A second similar bottle, in which sulphuric acid had stood undisturbed for some days, was placed in the beam: the dry air above the liquid proved absolutely silent.

On the evening of January the 7th Professor Dewar handed me four flasks treated in the following manner. Into one was poured a small quantity of strong sulphuric acid; into another a small quantity of Nordhausen sulphuric acid; in a third were placed some fragments of fused chloride of calcium; while the fourth contained

a small quantity of phosphoric anhydride. They were closed with well fitting india-rubber stoppers, and permitted to remain undisturbed throughout the night. Tested after twelve hours, each of them emitted a feeble sound, the flask last mentioned being the strongest. Tested again six hours later, the sound had disappeared from three of the flasks, that containing the phosphoric anhydride alone remaining musical.

Breathing into a flask partially filled with sulphuric acid instantly restores the sounding power, which continues for a considerable time. The wetting of the interior surface of the flask with the sulphuric acid always enfeebles, and sometimes destroys the sound.

A bulb, less than a cubic inch in volume, and containing a little water, lowered to the temperature of melting ice, produces very distinct sounds. Warming the water in the flame of a spirit-lamp, the sound becomes greatly augmented in strength. At the boiling temperature the sound emitted by this small bulb* is of extraordinary intensity.

These results are in accord with those obtained by me nearly nineteen years ago, both in reference to air and to aqueous vapour. They are in utter disaccord with those obtained by other experimenters, who have ascribed a high absorption to air and none to aqueous vapour.

The action of aqueous vapour being thus revealed, the necessity of thoroughly drying the flasks, when testing other substances, becomes obvious. The following plan has been found effective. Each flask is first heated in the flame of a spirit-lamp till every visible trace of internal moisture has disappeared, and it is afterwards raised to a temperature of about 400° C. While the flask is still hot, a glass tube is introduced into it, and air freed from carbonic acid by caustic potash, and from aqueous vapour by sulphuric acid, is urged through the flask until it is cool. Connected with the ear-tube, and exposed immediately to the intermittent beam, the attention of the ear, if I may use the term, is converged upon the flask. When the experiment is carefully made, dry air proves as incompetent to produce sound as to absorb radiant heat.

In 1868 I determined the absorptions of a great number of liquids whose vapours I did not examine. My experiments having amply proved the parallelism of liquid and vaporous absorption, I held undoubtingly twelve years ago that the vapour of cyanide of ethyl and of acetic acid would prove powerfully absorbent. This conclusion is now easily tested. A small quantity of either of these substances, placed in a bulb a cubic inch in volume, warmed, and exposed to the intermittent beam, emits a sound of extraordinary power.

I also tried to extract sounds from perfumes, which I had proved in 1861 to be absorbers of radiant heat. I limit myself here to the vapours of patchouli and cassia, the former exercising a measured absorption of 30, and the latter an absorption of 109. Placed in dried flasks, and slightly warmed, sounds were obtained from both these substances, but the sound of cassia was much louder than that of patchouli.

Many years ago I had proved tetrachloride of carbon to be highly diathermanous. Its sounding power is as feeble as its absorbent power.

In relation to colliery explosions, the deportment of marsh-gas was of special interest. Professor Dewar was good enough to furnish me with a pure sample of this gas. The sounds produced by it, when exposed to the intermittent beam, were very powerful.

Chloride of methyl, a liquid which boils at the ordinary temperature of the air, was poured into a small flask, and permitted to displace the air within it. Exposed to the intermittent beam, its sound was similar in power to that of marsh-gas.

The specific gravity of marsh-gas being about half that of air, it might be expected that the flask containing it, when left open and erect, would soon get rid of its contents. This, however, is not the case. After a considerable interval, the film of this gas clinging to the interior surface of the flask was able to produce sounds of great power.

A small quantity of liquid bromine being poured into a well-dried flask, the brown vapour rapidly diffused itself in the air above the liquid. Placed in the intermittent beam, a somewhat forcible sound was produced. This might seem to militate against my former experiments, which assigned a very low absorptive power to bromine vapour. But my former experiments on this vapour were conducted with obscure heat; whereas, in the present instance, I had to deal with the radiation from incandescent lime, whose heat is, in part, luminous. Now the colour of the bromine vapour proves it to be an energetic absorber of the luminous rays; and to them, when suddenly converted into thermometric heat in the body of the vapour, I thought the sounds might be due.

Between the flask containing the bromine and the rotating disc I therefore placed an empty glass cell: the sounds continued. I then filled the cell with transparent bisulphide of carbon: the sounds still continued. For the transparent bisulphide I then substituted the same liquid saturated with dissolved iodine. This solution cut off the light, while allowing the rays of heat free transmission: the sounds were immediately stilled.

Iodine vaporised by heat in a small flask yielded a forcible sound, which was not sensibly affected by the interposition of transparent bisulphide of carbon, but which was completely quelled by the iodine solution. It might indeed have been foreseen that the rays transmitted by the iodine as a liquid would also be transmitted by its vapour, and thus fail to be converted into sound.*

To complete the argument:—While the flask containing the bromine vapour was sounding in the intermittent beam, a strong solution of alum was interposed between it and the rotating disc. There was no sensible abatement of the sounds with either bromine or iodine vapour.

In these experiments the rays from the lime-light were converged to a point a little beyond the rotating disc. In the next experiment they were rendered parallel by the mirror, and afterwards rendered convergent by a lens of ice. At the focus of the ice lens the sounds were extracted from both bromine and iodine vapour. Sounds were also produced after the beam had been sent through the alum solution and the ice lens conjointly.

With a very rude arrangement I have been able to hear the sounds of the more active vapours at a distance of 100 feet from the source of rays.

Several vapours other than those mentioned in this abstract have been examined, and sounds obtained from all of them. The vapours of all compound liquids will, I doubt not, be found sonorous in the intermittent beam. And, as I question whether there is an absolutely diathermanous substance in nature, I think it probable that even the vapours of elementary bodies, including the elementary gases, when more strictly examined, will be found capable of producing sounds.

* In such bulbs even bisulphide of carbon vapour may be so nursed as to produce sounds of considerable strength.

* I intentionally use this phraseology.

SPAGNOLETTI'S RAILWAY SIGNALLING APPARATUS.

THE object of this apparatus is the interlocking of the out-door semaphore signals with the block telegraph system by electrical and mechanical means, the trains themselves taking part in the working of the system. The following is the arrangement :—To the signal frame is attached a catch lock working in the lever lock, which catch is duplicated to lock the lever also. Attached to this is a balance weight, and on the lever frame is a spring and stop piece acted on by movement of the lever for relocking it. A coloured disc indicator is attached to the frame to show when the lock is "on" or "off," and also a handle for unlocking the signal lock if required, under lock and key, the latter being kept by the station master or inspector. By these arrangements the knuckle lock of the signal lever, or the lever itself, can be either kept locked or be released at the pleasure of the signalman at the station in advance. An electro-magnet is so arranged as to act upon a small lever bar; when the latter is in its normal position the lever cannot be moved to lower the signal, but when the bar is attracted by the magnet the lever can be moved, the signal lowered, and again be restored to its position of "danger only," and is then again locked. An electro-magnet is also placed in circuit with the line wire with a soft iron armature, and when the current is sent to release the signal the line wire is disconnected, and no second current can be sent to allow a following train to proceed until the previous one has arrived

FIG. 1.

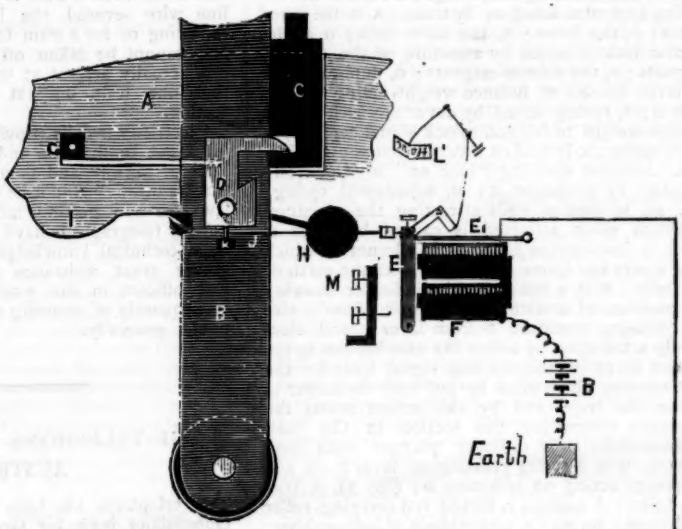


FIG. 3.

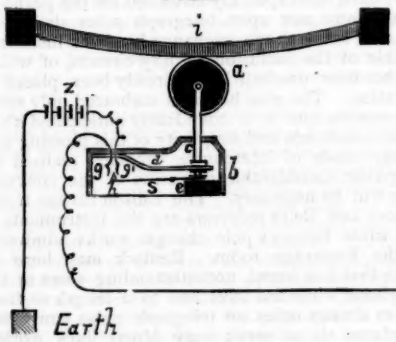
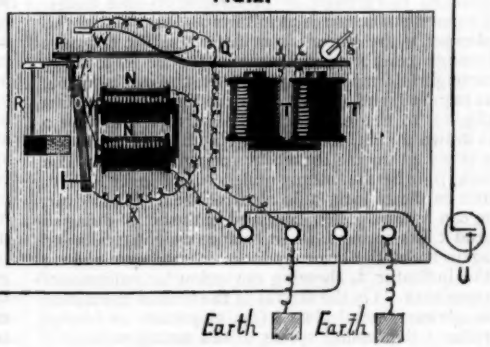


FIG. 2.



and reset the apparatus to complete the circuit of the line wire, or until the lever allowing the train to enter the next section has been lowered and put to "danger" again. This apparatus is worked electrically by the train or lever. A releasing relay is used with two sets of electro-magnets, one to draw an armature which is caught with a catch and the other to release the catch holding the armature.

Fig. 1 is a view of the locking apparatus; fig. 2 a view of the releasing relay; fig. 3 a view of the resetting apparatus acted on by train. A is the lever frame; B, the lever; C, the lever lock; D is the electric lock actuated by armature of the electro-magnets; F, the electro-magnets; G, duplicate lock in lever frame; H, balance weight acting on the lock D; I, spring raised by lever B, which allows balance weight to fall and relock signal catch C; J, catch spring; K is stud on lever for releasing spring, I; L, indicator showing "lock on" or "lock off" actuated by armature E; M, adjustment spring; (fig. 2), N, pair of coils attracting the armature, O, which when attracted is caught by lever P, which is insulated at *p*; Q is the fulcrum on which lever P acts and forms connection with the earth or line wire; R is a red and white indicator showing the position of armature O; T, pair of coils also for releasing armature O from lever P, and electrically acted upon by either the attachments to the train or lever on the starting signal lever for the next section, which must be put back to danger to protect the train, and by this action resets the apparatus controlling the section in the rear, as described; U is ordinary plunger with long contact; W is a spring pressing on lever P; X and Y, springs acting on armature O; (fig. 3), *a*, friction roller; *b*, casing; *c*, forked rod carrying roller *a*; *d*, strong spring; *e*, spring block of india-rubber; *f*, multiplying lever; *g*, springs for contact making; *h*, contact piece of required metal; *i*, metal plate attached to carriage, by preference to axle boxes. The mode of action is as follows:—On pressing the plunger, U, the current from battery, B, (fig. 1) passes through coils N to armature O, thence to lever P, through fulcrum Q and spring W to the earth or line, as required, and also through the line wire to coils F (fig. 1), to the earth. By the current, armature O is drawn up and locked by P (fig. 2), and armature E is pulled up and locked by spring I (fig. 1). The lock, D, is by this means pulled out of lever lock, C, and duplicate lock, G, is also released. The lever, B, can now be pulled over, and in the act of doing so stud K lifts spring I, when balance weight H falls and again locks the lever by locks or catches D and G; the indicator, L, showing the action for guidance of signalman. On the arrival of the train at the station in advance, metal plate *i* (fig. 3) presses on friction roller *a*, depressing spring *d*, and acting on lever *f*, actuating *h* to make contact between *g* and *g*^{1}. Block *e* supports roller *a* and forked rod *c*, by which means electric current from battery *z* to coils T acting on lever P releases armature O to reconnect the line wires; E^1 is a rod, so that armature *e* can be acted upon by hand. This and lever S (fig. 2) are kept under lock and key.

The system of resetting the apparatus at the station in the rear by the movement of the lever that works the starting signal for the next section in advance when it is put to "danger" after the train has left, can be applied in various ways to signal and point levers for sidings, so that the same safety is afforded to trains that do not go further than the station or junction and are shunted to another line or into a siding, which is an additional element of safety in railway working.

For single lines and tunnels this system is admirably adapted, as the lock on the signal lever at each end of the section is controlled by the signalman at the other end, and being worked by one line wire, when a train is once on the line and the line wire severed, the lock for a second train following or for a train to start from the opposite end cannot be taken off until the train on the line actually arrives at the end of its section, so that one train only at a time can be on the section.

Electricity is daily proving itself a still more useful agent to the safe and convenient working of lines of railway, and is of such an elastic nature that its utilities cannot be enumerated, and since its laws are now getting more generally understood railway telegraphists have a good opportunity, from their technical knowledge of railway working, of giving great assistance and advantages to railway officers in the working of their lines, and consequently of securing safety of travelling to the public generally.

THE TELEPHONE IN QUEENSLAND, AUSTRALIA.

THE telephone has been recently introduced into Queensland both for Governmental and private use, not alone at the capital, Brisbane, but also at some of the small coast towns north. In the city, wires have been specially stretched for the purpose, for the most part upon telegraph poles already in use, and a telephone exchange has been instituted capable of the inclusion of fifty circuits, of which number over one-half have already been placed in operation. The plan has been embraced only some few months, and it is confidently anticipated that, as the excellence and simplicity of this pleasing and speedy mode of intercourse becomes realised by the public, considerable extension of the convenience will be necessary. The Edison carbon transmitters and Bell's receivers are the instruments in use, while Edison's pole changer works admirably in the Exchange room. Remark may here be made that it is found, notwithstanding some of the telephone wires are stretched to a length of from one to sixteen miles on telegraph poles conveying in places six or seven busy Morse lines worked by closed circuit, induction from these latter currents gives little or no trouble, in no case interfering with the successful working of the telephone.

The terms upon which telephonic communication is conceded to the general public, either with the Exchange or between business or private houses, are that the Government provides and maintains the lines for a rental of £5 per mile per annum, and those participating in the benefit supply and keep in working order the required in-

struments, which, by regulation, must be *solely* used for their *own* business. For distances over five miles special arrangements can be made. And it is computed that the revenue to be derived from this source will yield more than remunerative interest upon the cost of construction and maintenance of the private sections of such lines.

RECENT IMPROVEMENTS IN LIGHTING BY ELECTRICITY.

ON Wednesday afternoon Mr. R. E. Crompton read a paper at the Royal United Service Institution on the above subject before a large audience. Mr. Nicholson occupied the chair.

Mr. Crompton said that the year 1880 would be looked back to as a year of great progress in the history of the electric light. The commencement of the year was marked by the natural reaction in public feeling, consequent on the disappointment which followed on the collapse of Edison's famous promises. His great name as an inventor had been used as a lever by unscrupulous manipulators of gas stock to depress their value to such an extent that it had most disastrous consequences to many of the holders, and part of the discredit which should have fallen solely on the ring of speculators who created the panic fell upon the electric light itself, and had most materially retarded its progress and general introduction. However, the various electric light companies had fought down that feeling at great expense to themselves by allowing a free trial of their apparatus, and had succeeded in restoring public confidence. A great wave of interest had been excited in the subject, which he believed would lead to the general adoption of the electric light. Some better lighting was a necessity of modern life. Darkness, that bugbear of the tactician, that friend of secret night surprises, must be under our control. Taking the principles which underlay the production of the light, and also the improvements that have been brought forward during the past year, he divided his subject into two heads—first, the production of the current of electricity; secondly, the transformation of this current into light.

(1). Sir Humphrey Davy discovered the light eighty years ago, but so long as the battery had to be relied upon it was impossible to introduce the light generally. A great impulse was given to the subject by Faraday when he discovered the main principles of dynamic electricity; another stride was made when the French workman Gramme combined with this dynamic electricity the self exciting or reacting principles. The lecturer exhibited one of Gramme's machines, and entered into a description of its principles. The Siemens' machine was almost identical with the Gramme. There might be mechanical differencces, but practically it was the same. The Brush machine differed considerably from both. Instead of having a continuous soft-iron ring—a ring of wire was usually used—it had a large cast-iron ring with a number of transvere grooves cut into its surface. It had also a different form of connecting cylinder. But the main thing claimed as an advantage in the Brush machine was that there were two sets of brushes so arranged that this connecting cylinder alternately switched the current on to the magnets and to the external circuit, preventing the reversal of the polarity of the current which was sometimes considerable. There were some machines called alternating current machines. Without describing them very fully he would say that their day had gone by. They were the first machines made and were not suitable to naval or military requirements, because of the danger to life and limb. All the fatal accidents that had occurred since the introduction of the electric light were cases where alternating current machines were used. In both the accidents on the *Livadia* and at Aston Park, Birmingham, alternating current machines were used, and he was not aware that any accident whatever had occurred with continuous current machines.

(2). As to the transformation of the current into light, real improvement and progression had been made during the year. The early methods of using the lights was by means of lamps regulating the length of the electric arc. That was a complicated process, and an invention had been made which obviated its necessity altogether. Electric light depended upon no new principle. There was the undeniable electrical law that a current of electricity generated heat in the body through which it passed in precise proportion to its resistance. It would not be safe to attempt to give a definition of what resistance was; it was sufficient to note that of two bodies similar in substance the thicker offered less resistance to the passing of a current than the thinner body, and the body that offered the least resistance was the best conductor. A great deal depended on the material of the conductors; copper and silver were the best, and at the other end of the scale was carbon—an easily obtained substance. But if carbon could be employed it was what all inventors would work with; even Edison had at last fallen back upon it. By means of three slender filaments of carbon they were able to get a very splendid light; there was this difficulty—metals, such as platinum for instance, did not oxidise, but carbon itself, combining with the oxygen of the air would burn away, and the slender filament of carbon would be dissipated. It was that combustion that they had to prevent. They had now got so far as a lamp which was a combination of a filament of carbon with a protecting chamber, which might, of course, be of glass. The first step in this direction was made by Mr. Swan, of Newcastle. He, after working on this subject for sixteen years through good and evil report, had at last produced a lamp which, so far as we could see, was approximately perfect. It was excessively simple, consisting of nothing but a glass globe from which the air had been exhausted by a most perfect form of pump, which had been improved on by Mr. Swan and his *collaborateur*, Mr. Stern, of Birkenhead. Having got this vacuum he also made certain improvements in the method of connecting the carbon, and in the way in which the platinum wires inside were prevented from working loose and thereby admitting the leakage of air into the pump.

Mr. Crompton went on to describe the invention of Mr. Lane-Fox, who had attained, with Mr. Swan, similar results, but by a different process; he also described the André and the Reynier lamps, and the lamp specially devised by Mr. Swan for coal-mining purposes. This subject was never mentioned without Mr. Edison's name being brought into it. It was very unfair to other electricians, who had done so much work for many years, that their labours should be thought so little of, and that so much should be thought of Mr. Edison, who, in the opinion of those who knew most of the matter, had done nothing for the electric light. Mr. Edison was simply "got at" by a very powerful clique, told to invent something with the electric light, and directly he said he had invented something, the news was telegraphed to the proper quarters, and gas stock was dealt with: it was what was called an American Wall Street plant. He would not deny that Mr. Edison was an extremely clever

inventor, but it was a curious thing that he produced, as an original invention, a lamp similar to Mr. Swan's, and did not produce it until after Mr. Swan's lecture on the subject describing those lamps, two years ago. The lecturer went on to give a full description of the lamps which used the electric arc, illustrating his remarks by one of those lamps. The objection to that lamp was that as it was not a continuous current it required regulation. A hand-regulator had been invented for that purpose. He next gave an account of the electric candles, and passing on to the penetrating power of the light in fog, he showed that the only portion of the electric current which had power to penetrate fog was that coming from the bottom of the carbon—that part technically called the crater. He spoke of the uses to which the light had already been put for naval purposes, and pointed out several respects in which its utility might be increased; for instance, in the case of a large force requiring to be disembarked within a short space of time along a dark coast. Summarising the progress made during the year, he said that whereas the cost per hour was 1s. or 1s. 2d. per light per hour, they could now produce the same at 7d. or 8d. They had doubled the efficiency of the lamps, and had at the same time halved the price.

At the request of a gentleman, Mr. Crompton gave a long and interesting account of Professor Graham Bell's latest invention, the photophone, by means of which the human voice is transmitted to a distance through the agency solely of a beam of light.

In the discussion that ensued, Mr. Lane-Fox defended Mr. Edison against the disparaging remarks the lecturer had made.

Mr. Crompton was about to reply, when the chairman intimated that at that institution any matter of controversy was strictly excluded.

Several questions were asked and replied to by the lecturer, and the company separated.

TELEGRAPHIC APPARATUS IN USE IN THE BRITISH POSTAL TELEGRAPH DEPARTMENT.

XXVI.

THE WHEATSTONE AUTOMATIC SYSTEM.

(Continued.)

THE resistance to which the coils of the Wheatstone receivers are wound, in the latest instruments, is 200 ohms each coil, so that if they are coupled up in "series" the total resistance in circuit is 400 ohms. If they are coupled up for "quantity" the resistance is reduced to 100 ohms.

The coils are wound exactly in the same way as in the "standard relay" (Article V.), and "links" are provided, so that the coils can be coupled up either in "series" or "quantity."

It has been found that a high rate of speed is best obtained when the coils are coupled up for "quantity"; but in wet weather, when the leakage on the line is considerable, a low resistance does not enable sufficient magnetic effect to be generated to produce good signals: in this case, therefore, the "series" arrangement must be adopted although the speed of working is reduced thereby.

Some of the older forms of the instruments were wound to a resistance of 400 ohms each coil, or a total of 800 ohms in series. As this high resistance is found to be prejudicial to high speed, these coils have been joined up internally and permanently for quantity, as shown by fig. 105: thus the resistance of each coil is reduced to 100 ohms. When the terminals outside are joined up in "series," therefore, the coils are actually joined up for "quantity," the total resistance being 200 ohms. When the links are arranged for "quantity" the coils become joined up for "double quantity," giving a resistance of 50 ohms. Experiments seem to prove that the double quantity arrangement, with thin wire on the coils, gives a better effect as regards speed of working than does single quantity with thicker wire, although the combined resistances are similar in both cases.

It has been found that the mass of iron in the cores affects considerably the speed of working; hence the cores are considerably lighter in the most recent pattern of the instrument than in the older forms.

THE LOCAL CONNECTIONS.

Besides the "transmitter" and "receiver," every complete set of Wheatstone apparatus includes a galvanometer, a sounder, and a double current key, these latter being required for hand working, so that corrections, &c., can be given when necessary.

Connected to the hand lever shown at the left hand in fig. 90 (Article XXIV.) is a compound switch, by means of which the transmitter is switched out of circuit, and the double current key brought in in its place.

The arrangement of the switch, which is placed underneath the base of the transmitter, is shown by fig. 106. It consists of three insulated brass levers, A, B, and N, linked together by an ebonite bar, G, which latter is linked to the lever before referred to in fig. 90. When the latter lever is moved to the position in which it allows the clockwork of the transmitter to run, then the levers, A, B, and N, are in the position indicated in fig. 106.

By the help of fig. 88 (from Article XXIII.) we can trace out the connections. In this figure, for simplicity, the connections have been shown as if they were joined direct on to the various terminals, but actually they do so through the medium of the different pieces in the switch. The lettered arrowheads, ⟶, in fig. 106 show the connections which are actually joined on to the correspondingly lettered parts of the transmitter. The connections are, therefore, as follows:—The Copper of the battery is connected to the lever, A, from thence to contact-piece, *a*, and to the crank lever, C (fig. 88); similarly, the Zinc pole of the battery is connected to lever B, and from thence to contact-piece, *b*, which is itself connected to the crank-lever, Z (fig. 88).

If now the levers, A and B, be turned over to the right, which would take place if the clockwork of the transmitter were stopped, then the Copper pole of the battery will be connected through lever A and contact-piece *c*, with the C terminal of the double current key; similarly, the Zinc of the battery is connected through the lever, B, and contact-piece,

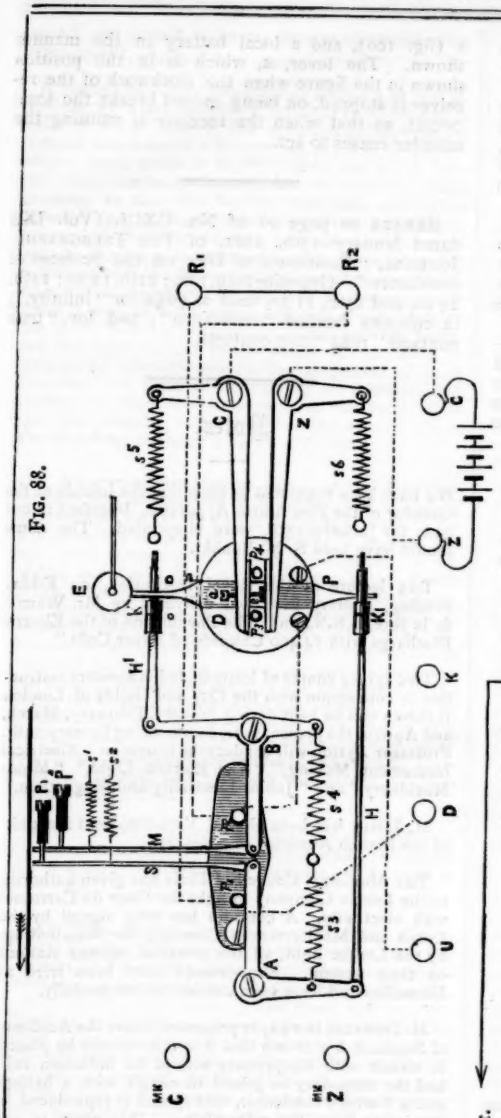


FIG. 88.

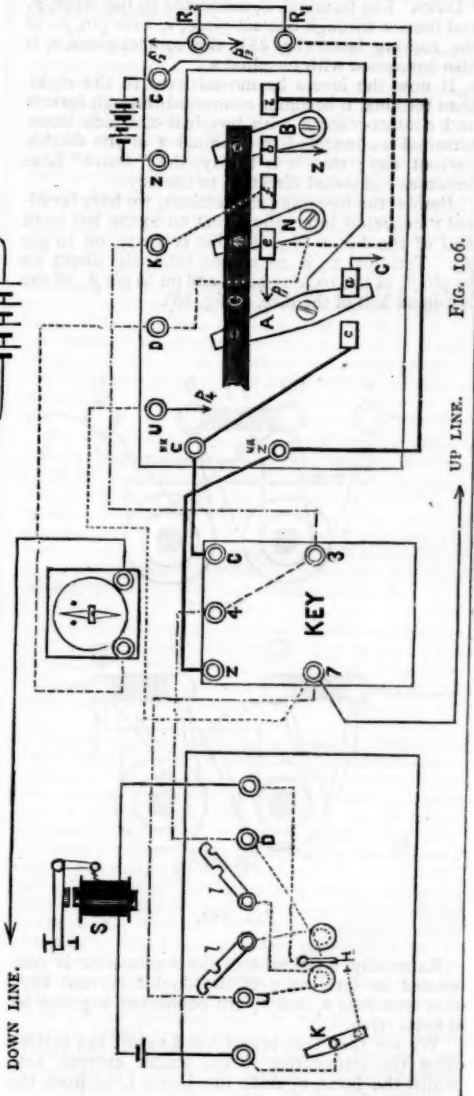


FIG. 106.

z, with the z terminal of the key, thus the battery is transferred from the transmitter to the double current key.

Supposing again, the levers, A, B, and N, to be in the position shown in the figure, then we have the "Down" line terminal, D, connected to the lever, N, and thence through contact-piece, *e*, with pin, p_1, of the rocking beam (fig. 88); the contact-piece, *e*, is also connected with terminal R_1.

If now the levers be moved over to the right, then terminal D becomes connected through lever N and contact-piece *f*, with terminal K, which latter terminal is connected to terminal 3 of the double current key; that is is to say, the "Down" Line becomes connected direct on to the key.

Besides the foregoing connections, we have terminal U conected internally direct on to the left-hand half of the disc, D (fig. 88), that is to say, on to pin p_4. Terminal R_2 is connected internally direct on to pin p_2 of the rocking beam and on to pin p_3 of the left-hand half of the disc, D (fig. 88).

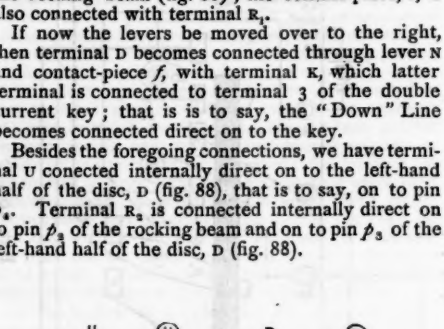


FIG. 105.

Externally, terminal U of the transmitter is connected to terminal 7 of the double current key; also terminals R_1 and R_2 are connected together by a brass strap.

We see then that levers A and B shift the battery from the transmitter to the double current key, whilst the lever, N, shifts the Down Line from the transmitter to the key.

The Up Line is connected to terminal 7 of the key, and to terminal U of the receiver, and also to terminal U of the transmitter.

In order to actuate the sounder, S, the lower tongue, F_1 (fig. 99, Article XXV.) of the electromagnet armature has a contact stop as in an ordinary relay; this contact stop is connected to the sounder, S (fig. 106), and a local battery in the manner shown. The lever, K, which is in the position shown in the figure when the clockwork of the receiver is stopped, on being moved breaks the local circuit, so that when the receiver is running the sounder ceases to act.

ERRATA on page 26 of No. CXCI. (Vol. IX.) dated January 15th, 1881, of THE TELEGRAPHIC JOURNAL, "Resistance of Dew on the Surfaces of Insulators:"—Opposite 10th, 12·0; 11th, 12·20; 12th, 14·20, and 15th, 11·20, read ∞ (sign for "infinity,") in columns headed "resistance"; and for "true contacts" read "tree contacts."

Notes.

WE have been requested to state that the initials of the inventor of the Fire Alarm Apparatus, described in our issue for January 15th, were misprinted. The name should have been S. M. Banker.

THE lecture at the Royal Institution, on Friday evening, January 21st, was delivered by Mr. Warren de la Rue, F.R.S., on "The Phenomena of the Electric Discharge with 14,400 Chloride of Silver Cells."

THE spring course of lectures and laboratory instruction in connection with the City and Guilds of London Institute will be held during January, February, March, and April of the present year, commencing January 24th. Professor Ayrton will conduct the course on "Electrical Instrument Making," "The Electric Light," "Motor Machinery," and "Junior Electricity and Magnetism."

M. JAMIN has been elected Vice-President for 1881 of the French Academy of Sciences.

THE Municipal Council of Paris has given authority to the Lontin Company to light the Place du Carrousel with electricity. A contract has been signed by the Lyons and Mediterranean Company for illuminating, by the Lontin light, all the principal railway stations on their system. Experiments have been tried at Marseilles and have been carried out successfully.

M. DUNAND, in a paper presented before the Academy of Sciences, has shown that if a microphone be placed in circuit with the primary wire of an induction coil, and the secondary be joined in circuit with a battery and a Varley's condenser, that speech is reproduced in the latter from the microphone. This effect is not produced unless a battery is in the secondary circuit.

ARRANGEMENTS have been completed with the British Electric Light Company for the experimental lighting of certain important parts of the General Post Office, St. Martin's-le-Grand. The first series of experiments will be conducted in the Telegraph Instrument Galleries.

Mr. ALFRED R. BENNETT, M.S.T.E., late Engineering Superintendent to the United Telephone Company, has been appointed engineer and manager of Messrs. D. and G. Graham's telegraphic and telephonic system, which extends over the whole of Glasgow and for thirty miles

around, and is said to be on the eve of considerable development.

A PATENT has been taken out in America by Mr. E. Berliner, for a photophonic transmitter in which use is made of a heat-flame of low luminous quality—as, for instance, the flame of a Bunsen burner, or of an oxyhydrogen light, which is hardly visible, but which may heat other substances brought into its reach to incandescence, so that they become luminous, and to an extent as they are brought into contact with the flame. A pencil of platinum, calcium, asbestos, or similar refractory substance is arranged so that its point is just in contact with the flame, and this pencil is vibrated by means of a diaphragm to which it is secured, or by which it may be acted upon. By this means more or less of the pencil is brought in contact with the flame, and the light emitted by the pencil will therefore in strength be proportionate to the amplitude of each vibration, and light-waves, varying in intensity and number in proportion to the transmitted sound-waves and their intensity, will result from this manipulation. The idea does not seem a very happy one.

IN his annual message to Congress the President suggests the consideration of the necessity of extending Government aid to a Pacific telegraph cable. He says:—In this connection I desire also to suggest the very great service which might be expected in enlarging and facilitating our commerce on the Pacific Ocean, were a transmarine cable laid from San Francisco to the Sandwich Islands, and thence to Japan at the north and Australia at the south. The great influence of such means of communication on these routes of navigation, in developing and securing the due share of our Pacific coast in the commerce of the world, needs no illustration or enforcement. It may be that such an enterprise useful and in the end profitable as it would prove to private investment, may need to be accelerated by prudent legislation by Congress in its aid, and I submit the matter to your careful consideration.

A NEW electric lamp has been brought out in Paris; it is a combination of the Werdermann with a perforated carbon filled by an insulating medium. It is said to work well.

THE U.S. Consul-General at Shanghai, China, informs the State Department at Washington that the Emperor of China has given permission for the construction of a telegraph line from Shanghai to Tientsin, a distance of 1,200 miles. The route will be from Shanghai to Chinkiang, thence along the line of the Grand Canal to Tientsin. A short line of about 70 miles will also probably be constructed by the Viceroy at Nankin to connect the capital of his province with the main one at Chinkiang. The work of setting the poles and laying the wire will be begun early next spring. It is estimated that the work will cost 500,000 dols.

ON Monday, December 20th, the first trial of electric street lighting in New York was made. The territory selected was the portion of Broadway between Fourteenth and Twenty-ninth streets, three-quarters of a mile in extent, and was traversed by 10,000 feet of wire. The generators are run by a Corliss engine of 125 horse-power. On Monday night, 14 horse-power was used. Another engine is to be put in the station, and ultimately 500 horse-power will be generated there. Wires have been laid to Thirty-fourth street, and the current will be sent through them at an early day. It is said that the company expects to light for a mile east and west from the Twenty-fifth street station. Meanwhile, further trials are making to furnish data as to cost and the distance apart at which the lights should be placed, preparatory to an invitation to the Brush Company by the city officials to send in a bid for lighting a square mile of territory.

ON Wednesday, the 12th inst., Falmouth was put in direct telegraphic communication with Bilbao and Madrid by means of the cables of the Direct Spanish Telegraph Company. Congratulatory messages were exchanged between the Mayor of Falmouth and the Alcalde of Bilbao. The work of laying the cables underground between the Lizard and Falmouth has been conducted by Mr. J. Jeffery, A.S.T.E., assisted by Mr. R. Balkwill, and has been very successful throughout. The *pièce de resistance* in the construction of the land line was laying the cables across the arm of the sea at Helford, and the limited means at the disposal of the superintending officer of works enhanced the difficulty. A hawser was laid across the river, and by this means a barge belonging to the Gweek Company, laden with cable, was hauled across the river, paying out cable as it proceeded. One knot of this cable weighs 16 tons. The offices of the company are in the Post Office buildings, on the first floor.—*Falmouth Advertiser.*

WE have received from Messrs. Ransomes, Head & Jefferies, of Ipswich, a catalogue of engines manufactured by them for driving electric light machinery. This, we believe, is the first catalogue of the kind yet issued. Several of the engines are fitted with the dynamo machines on to their frames, and are very compact, whilst all the forms seem well suited for the purpose intended. Automatic governors are fitted, whereby great uniformity of speed is obtained.

M. CLAMOND, well known in connection with thermo-electric generators, has taken out a patent for the production of an intense white light. This is produced by heating air that is supplied to a gas flame, and projecting the latter on to a cylinder of lime.

IN a note to the Vienna Academy (*Anz.* December 16) Prof. Stefan describes experiments on the influence of terrestrial induction in development of an electric current, and the excitement of the telephone by currents from a rotating coil. The coil used was 56 mm. in external diameter, and 11 mm. in width. The earth's influence is best shown by so connecting the apparatus with a galvanometer that the circuit is closed during one half of the coil's rotation, and broken during the other half; if the completion of the circuit correspond to the positive maximum of the electromotive force of the earth's magnetism, and the interruption to the negative, the galvanometer is positively deflected. The deflection may be reduced to zero by displacing the contact, and from the displacement and the number of rotations the potential may be inferred in absolute measure. Next the telephone was so connected with the coil that the full alternately opposite currents went uninterruptedly through the circuit. This gave a simple tone. With 100 rotations per second the horizontal component of the earth's magnetism did not suffice to excite an ordinary telephone, but it excited one having a horse-shoe magnet. (When the intensity of the field was doubled the ordinary telephone was also excited.) The tone corresponds to the number of rotations. When the coil was rotated 220 times in a second the ordinary telephone sounded. The telephone was shown to be less sensitive to currents whose intensity periodi-

cally changes than to interrupted currents (an ordinary telephone sounded with 100 rotations or fewer, when the circuit was closed only during a short time of each rotation).—*Nature.*

IN the issue of *Nature* for January 20th Lord Rayleigh gives a mathematical investigation of the impact of intermittent radiation upon thin plates of various substances, in which he proves that the phenomena observed in the photophone are explicable upon the assumption that there is a periodic communication and abstraction of *heat* upon the diaphragm.

THEORY OF THE GALVANIC ELEMENT.—Prof. Fr. Exner.—An electro-separative force exists neither between the metals and the liquids nor in the metals among themselves, except in the cases where a chemical reaction is manifested. The total action of a galvanic element is exclusively derived from the chemical action which takes place in its interior. The formulæ expressing the free tensions of an open element, in as far as they proceed from this point of view, are in perfect harmony with the results of experience. It is the same with the tensions of a closed element. The author has traced, in accordance with these observations, diagrams of the potential levels of the chief galvanic elements.—*Academy of Sciences of Vienna.*

A CONTRIBUTION TO THE THEORY OF CONSTANT GALVANIC ELEMENTS.—N. Slouguinoff.—The author calculates the electromotive force of n elements connected together and of different electromotive power, as also the electromotive force of elements in which polarisation is manifested, and deduces hence the well-known electromotive law.—*Wiedemann's Beiblätter.*

COMBINED HOLTZ AND TÖPLER'S SELF-EXCITING INFLUENCE MACHINE.—R. Voss.—The author describes a machine of the form of that of Holtz, which can be converted into a self-exciting Töpler's machine by the introduction of other discs. The fixed disc has two paper coatings of the ordinary form and four tin-foil coatings, connected two and two, the latter being connected with two pieces of brass fitted with metal bows and metal brushes. The rotatory disc has six tin-foil coatings with metal projections which rub against the metal bows with their brushes. The double absorber has also two metal brushes which rub against the brass projections. The machine is said to be capable of acting in all conditions of the atmosphere provided the metal brushes touch the brass projections and not the glass. As regards quantity, the machine yields as much electricity as that of Holtz, but the length of the sparks is less by a couple of centimetres, since the electricity does not reach as high a tension as in the Holtz machine.—*Dingler's Journal*, 237, p. 476.

ON THE INFLUENCE OF CONCENTRATION UPON THE ELECTROMOTIVE FORCE OF A DANIELL'S ELEMENT.—J. V. Hepperger.—The electromotive powers of two Daniell's elements with sulphate of zinc solutions of different degrees of concentration, as calculated from the strength of the currents and the resistances, differ from each other as much as the powers of amalgamated zinc plates with the same solutions. The electromotive force of solutions of zinc and copper sulphates of different degrees of concentration was examined by means of the hair-electrometer. If we call the electromotive power of a 1 per cent. solution E, then:—

Solution.....	1	5	10	15	20	25	30	40
Zinc sulphate..	E	—	11	—	18	—	21	25
Copper sulphate	E	13	18	21	24	26	27	

$\frac{1}{1000}$ D is taken as unity. The current passes from the more dilute to the more concentrated solution. Between mercury electrodes the electromotive force of a 10 and a 50 per cent. solution of sulphate of zinc is respectively as — 20 and 0. The law of the series of tension naturally holds good here.

THE UNITED TELEPHONE COMPANY (LIMITED.)—The meeting of this Company adjourned, as stated in our last issue, from the 13th ult., was held on Thursday last, the 27th ult., to consider an agreement with a company yet to be formed, and to be called the Provincial Telephone company (Limited.) Mr. Brand, the chairman, having proposed a resolution as to its adoption, and the same having been seconded, after some discussion, was declared duly carried.

ON the 22nd ult. a heavy sleet storm raged on the North Atlantic seaboard. Many telegraph wires were broken, and the poles thrown down, causing great obstruction to business. Not a single telegraph wire from New York city could be worked.

THE Scottish Telephonic Exchange Company, Limited, has, in answer to an application, received from the Postmaster-General a form of proposed license which contains very onerous restrictions as to the details of working, and indicates a high scale of royalties. The company is negotiating with a view to obtain some modifications.

GLASGOW TELEPHONIC EXTENSION.—It is stated that Messrs. D. and G. Graham have received information from the Post Office authorities that their application for a license to carry on their telephonic system will be granted. This firm, prior to the case being taken against the Edison Telephone Company by the Government, had contracted with the proprietors of the Gower-Bell Telephone for the exclusive use of their instrument within a circuit of 30 miles round Glasgow. A large number of lines have already been laid for stock-brokers, shipbuilders, shipowners, and other establishments. The firm intend to open very shortly a Central City Telephonic Exchange in St. Vincent's Place, within two minutes' walk of the Exchange.

GLASGOW PHILOSOPHICAL SOCIETY.—At a meeting of the Glasgow Philosophical Society, held on the 19th January, Mr. A. Jamieson, C.E., principal of Glasgow Mechanics' Institution, read a paper on "The History of Selenium and its action in Professor Graham Bell's Photophone." After referring to the history of selenium and the results of experiments with it, he explained a simple cell which he had designed, and showed how sensitive it was to light by diagrams and apparatus in the form of a Wheatstone's bridge with Sir Wm. Thomson's reflecting galvanometer. He had tried the effect of singing gas flame, and found, to his surprise, that the tone was clearly reproduced by his sensitive selenium cell and a telephone. By one person speaking behind a sensitive membrane stretched across a gas-holder with a burner in front, the gas vibrated in perfect unison with the voice; the selenium cell rose and fell in resistance and governed the battery current, which effected in the telephone the exact song or words, and which were clearly audible at the end of a telephone joined in circuit at 200 feet distance. Sir Wm. Thomson, in moving a vote of thanks, said that Mr. Jamieson's experiments had added materially to the knowledge on the subject.

THE GOWER TELEPHONE.—We understand that the Indian Government Telegraph Department, which some time since refused to sanction the setting up of Telephonic Exchanges, has now decided itself to supply the Indian public with telephonic intercommunication. After having experimented with a first supply of about thirty of the Gower-Bell Company's loud-speaking instruments, an order has been placed with that Company for some hundreds of them.

Correspondence.

SEYMOUR'S BALANCE GALVANOMETER.

To the Editor of THE TELEGRAPHIC JOURNAL.

DEAR SIR,—I notice in the article on my galvanometer, an error in speaking of the different values of the readings in measuring current strength from the battery direct and through the patient—the article states, "it ranges from $\frac{1}{100}$ of a grain to '75 to 1;" it should be "from $\frac{1}{100}$ of a grain to about 2·5 or 3 grains.

Yours faithfully,
P. W. SEYMOUR.

Proceedings of Societies.

THE SOCIETY OF TELEGRAPH ENGINEERS.

THE first ordinary general meeting of this Society for the session commencing January, 1881, was held on the 26th inst.

The chair at the opening of the meeting was taken by Mr. W. H. PREECE. The minutes of the previous meeting having been read and confirmed, Mr. W. H. Preece introduced the new President, PROFESSOR G. CAREY FOSTER, F.R.S. A vote of thanks having been proposed to the retiring president by SIR CHARLES BRIGHT, and seconded by PROFESSOR W. G. ADAMS, Professor Foster took the chair, and read his inaugural address as follows:—

Professor Foster commenced by saying it was difficult for him to assign any reason for the choice of himself as the new president of the Society, he could only attribute it to disinterested kindness, or to the desire of the Society to be considered scientific as well as practical.

On the 21st July, 1821, Oersted made his discovery of the effect of the galvanic current upon the magnetic needle. Twelve months after he discovered the reciprocal action of currents on magnets and on each other. Arago followed up the results, and subsequently Sir Humphrey Davy made his well-known experiment of the electric light with 2,000 battery cells, at the Royal Institution.

In 1831 Faraday made the discovery of induced currents, which has led to the most important scientific and practical results. The reciprocity of electricity and electro-dynamic action was thus shown. Ampère's experiments showed the same facts in different aspects, and determined certain laws. The discovery of these facts gave two aspects to the phenomena, otherwise it would have simply been a discovery of natural history, and would have led to very little result. The discovery of the induced current was one of the very greatest importance, as the practical applications of the present day prove, such as the electric light, electro-motors, the telephone, &c. Faraday's discovery laid the foundation of all these inventions.

These practical results benefit science to a very great extent. If a new instrument is invented for practical use the laws affecting it become investigated. The use of the electric telegraph has led to an investigation of earth currents.

When operations are transferred from the workshop to the laboratory the object is changed, as then it is to get at the laws of the question and not to obtain a practical result that is aimed at; the criterion of success is different in the two cases. In both cases the importance is the same—in one case the aspect is qualitative and in the other quantitative. Until phenomena are reduced to mathematical laws their value cannot be estimated, since to make the phenomena of commercial value every effect must be understood. Thus the number of electrical machines which have been made within the last 100 years have been legion, but no distinct laws have been laid down as to its operation, whereas in the case of the galvanic battery, which has proved of so much practical value, the laws governing its action are well understood.

The progress made in the last 30 years in electrical science has amounted almost to a complete transformation, and all the facts learnt are now reduced to a clear basis.

One of the greatest aids in bringing about the progress has been the establishment of *standards*, which has enabled the doctrine of energy to be put on a firm footing. Arbitrary standards have merely reference to some fixed element of its own kind. Absolute standards have reference to the elements of time, space, and mass. It is the adoption of these standards which distinguishes the present from the past. It is necessary that a clear conception of the thing to be measured be gained, but this grows up in the course of time.

The first step towards the fixing of standards was made when Ohm enunciated his well-known law. Gauss in 1832 showed how an absolute measure could be obtained of the intensity of the earth's magnetism. In 1840 Weber showed how this could be applied to electric currents. Biot and Savart showed how Oersted's discovery could be expressed in the same way. Later Weber pointed out how a circular conductor when rotated could generate a definite current whose dimensions could be thus obtained in absolute measure; he further calculated the electro-chemical value of the current, showing how many grammes of water could be decomposed in a given time by a given amount of current.

In 1851 Weber published a complete theory, showing how the earth's magnetic intensity could be related to the dimensions of the electric current, and how the elements of length and time were involved. Ohm's law enabled this to be done, as all the terms are interchangeable. Two elements being known, the third can always be determined. Weber actually formed material standards and deposited them in the museum at Leipzic, the dimensions being 10, 5, and $\frac{1}{2}$ ohms.

Sir William Thomson fully appreciated and adopted Weber's reasoning, and he showed how the motion of a conductor through a magnetic field could be expressed in thermal and chemical units. He thus determined the value of the volt at 1·07 of a Daniell cell. The result depended upon energy only.

In 1856 Bosscha determined the value of the volt at 1·026 of a Daniell cell, and in 1858 the result was given as 1·09.

Since the value of the unit of resistance was determined, Mr. Latimer-Clark and Kohlrausch also determined the value of the Daniell cell.

About 1861 the necessity for expressing the measurements used in connection with the testing of submarine cables in standards was strongly felt, and in 1861, at the Manchester meeting of the British Association, a committee was appointed, who undertook the work of forming material standards, a grant of £50 being given for the purpose. The experiments lasted till 1870, during which time the sum of £590 had been granted. The advantage of the standards was abundantly recognised.

The value of the standard unit, as calculated by different workers, differed considerably, as under:—

1870	Kohlrausch	1·0196
1873	Lorenz	·9717
1876	Rowland	·9912
1877	Weber	1·002

It is very important that the time value be determined.

The experimental methods adopted depended upon induced currents with one exception, in which the measurement was made by the heat developed in a wire.

In Lorenz's method a steady current was employed by rotating a copper disc, this method is only mentioned as being a simple method, and accuracy is not claimed.

Dr. Schuster has been experimenting at the Cavendish Laboratory, Cambridge, with the original instruments, and further experiments are to be made with a new apparatus.

Considerable doubts having existed as to the permanence of the existing standards, experiments were made in 1867 by Dr. Crystal on the standards originally formed; these appeared to be quite correct and unchanged, with the exception of the platinum-iridium standard, which had gone down slightly. Dr. Fleming, who had made some experiments on the temperature coefficients, found five of the standards right and two different from the rest, but all agreed within $\frac{1}{1000}$th of each other.

Amongst the various methods of testing, two are capable of various applications as showing pure and applied science, viz., the Wheatstone bridge and Poggendorff's method of determining the relative electro-motive forces of batteries. Thomson's condenser method on the principle of the bridge was also to be enumerated, as well as Mann's method of determining the resistance of batteries. The condenser method had a practical application in the duplex telegraph system. Poggendorff's method gave rise to the "Potentiometer" of Mr. Latimer-Clark, and the latter instrument was useful for determining the absolute value of currents.

Sir Charles Bright's and Mr. Latimer-Clark's division of the units into decimal multiples has proved of great value, and the use of the *dyne* and the *erg* was suggested by the ohm and the volt.

In concluding his address, Professor Foster said that he would suggest that until the dimensions of the electrical units were settled beyond dispute, the Society of Telegraph Engineers and Electricians should become the depository of the standards for general use, and should issue certificates of the value of resistances submitted to them, as was done at the Kew Observatory with other standards.

At the conclusion of the address, a vote of thanks was proposed by Mr. EDWARD GRAVES, who said that it was a great point that the addresses of the presidents were always of a varied character. Great points of importance were brought forward by Professor Foster. His address was a *résumé* of scientific discoveries of a qualitative character which pointed to the necessity for exact calculation.

He begged to move that the address be printed in the Journal of the Society.

PROFESSOR HUGHES seconded the motion, which was carried unanimously.

A paper was then read by Mr. A. W. HEAVISIDE on "Telephonic Induction," in which the results of some experiments were given. It was pointed out that induction could be heard in a telephone held near a working circuit with no wires attached to the former. When the terminals of the telephone were short-circuited this effect entirely disappeared.

After some remarks by Professor HUGHES, Mr. STROH, and Mr. A. J. S. ADAMS, the meeting adjourned.

PHYSICAL SOCIETY.—JAN. 22.

Professor W. G. ADAMS in the Chair.

New member—Mr. G. PALGRAVE SIMPSON, B.Sc.

"Notes on the Construction of the Photophone," by Professor Sylvanus Thompson, were read by Professor RHEINOLD. Professor Thompson was led by experiment to question whether Professor Bell's form of photophone receiver was adapted to give the best results. Theoretically, he finds, with a given maximum of incident light distributed uniformly over the surface, the change of resistance in a selenium receiver will vary proportionally with its linear dimensions, provided its parts be arranged so that, on whatever scale constructed, the normal resistance shall remain the same. A cell, n times greater linearly each way, will produce n times the variation in resistance for the same total amount of light. This follows, from Professor W. G. Adams' law, that the change in the resistance of selenium is directly as the square root of the illuminating power. The author also finds that if the thickness of the conducting discs in the enlarged cell be kept the same as before, and their number increased n times, the change of resistance will be n^3 times as great as before. Selenium cells should therefore be as large as possible, and the light should be distributed over them uniformly, not focussed to a point. A conical mirror would, therefore, be better than a parabolic one to receive the beam. Such a reflector would be cheaper to construct, and there would be a minimum of loss by reflection, as the light would fall perpendicularly on a cylindrical cell parallel to its axis. To give the best effect its angular semi-aperture should be 45°, and this will bring the front end of the cell in the same plane as the mouth of the reflector. Professor Thompson has also constructed an improved cell by winding parallel wires on a cylinder of slate grooved with a double-threaded screw and filling the interval between them with selenium. This form gives superior effects to Professor Bell's disc devices.

Mr. SHELFORD BIDWELL said that long annealing improved the sensitiveness of selenium for photophonic purposes. He got the best speech from cells of high total resistance made with fine wire. The selenium should, however, have a low specific resistance. With the apparatus he showed at a recent meeting of the Society he could now transmit articles from *Nature* and the *Nineteenth Century* so that every word could be heard by the listener.

Professor GUTHRIE suggested that amorphous phosphorus should be tried in place of selenium, as a more permanent substance.

Mr. GLAZEBROOK, of the Cavendish Laboratory, Cambridge, read a paper on the measurement of small resistances, and the comparison of the capacities of two condensers. In measuring small resistances by the Wheatstone balance the results differed on varying the resistance in the battery wires. According to Professor Crystal, this was due to a thermo-electric effect produced at the middle point of the divided platinum-iridium wire when the contact is made with it. It could be avoided by making this contact first, and then making the battery contact. Mr. Glazebrook investigated the effect mathematically and experimentally. He suggested that the resistance in the battery wire should be kept small in comparison with the other resistances, and then the effect was inappreciable. It could also be eliminated by taking two measurements with reversed currents and calculating out. The author next considered the effect of a small leakage in comparing condensers by the Wheatstone balance method.

Dr. HOPKINSON stated that he had found a modification of this plan to be very promising. For the battery

he uses an induction coil, and for the galvanometer a telephone. Thus a high electromotive force and sensibility was obtained.

New Patents—1881.

39. "Improvements in street curbs and gutters intended for the reception of telegraph wires." H. J. HADDAN. (Communicated by J. D. Townsend.) *Complete.* Dated January 4.

48. "Apparatus for generating and utilising electricity for lighting and other purposes." W. R. LAKE. (Communicated by E. Etève.) Dated January 4.

56. "Mechanical telegraphs." W. CHADBURN. Dated January 5.

65. "Electric lighting." J. M. JUSTICE. (Communicated by H. C. Spalding.) Dated January 6.

78. "Dynamo-electric machines for electric lighting." J. E. H. GORDON. Dated January 6.

93. "Telephonic apparatus and conductors." J. IMRAY. (Communicated by C. Herz.) Dated January 8.

108. "Improved apparatus for and means of converting heat into electricity." J. C. RAMSDEN. Dated January 8.

129. "Improvements in galvanic polarisation batteries, or magazines of electricity, and the application of the same, and in apparatus connected therewith." J. H. JOHNSON. Dated January 11.

152. "Electric batteries." J. A. LUND. Dated January 12.

153. "Electric lamps." A. MUIRHEAD and J. HOPKINSON. Dated January 12.

200. "Transforming, conveying, and applying power by means of electricity, and apparatus for that purpose." J. IMRAY. (Communicated by J. E. Cavanellas.) Dated January 15.

218. "Apparatus for producing electric light." J. E. H. GORDON. Dated January 17.

225. "Improvements in electric lamps, in the manufacture of parts thereof, and means of turning on and off electric currents for lighting and extinguishing lamps for other purposes." St.-G. L. FOX. Dated January 18.

229. "Improvements in the process of restoring waste vulcanised india-rubber or gutta-percha, and in compounds produced thereby; which invention also comprises improvements in telegraphic or telephonic wires coated and covered with such compounds or other materials." H. H. LAKE. (Communicated by H. A. Clark.) *Complete.* Dated January 18.

245. "Improvements in the construction of apparatus for lighting gas, which improvements are also applicable to other electrical appliances." C. L. CLARK and J. LEIGH. Dated January 20.

253. "Improvements in apparatus for producing electric currents and applying them for illumination, and for the transmission of power, as for example, for the steering of ships." C. G. GUMPEL. Dated January 20.

264. "Certain improvements in apparatus for measuring, generating, and using electric currents." A. APPS. Dated January 21.

275. "Electric semaphores for railway purposes." W. R. LAKE. (Communicated by F. R. F. Brown.) *Complete.* Dated January 21.

286. "Telephones." F. H. F. ENGEL. (Communicated by J. H. Königsleib.) Dated January 22.

288. "Improved method of and appliances for controlling and regulating the speed of engines employed for driving dynamo-electric machines." J. RICHARDSON. Dated January 22.

304. "Improvements in the manufacture of carbon and graphite, which invention also comprises the formation of these materials into rods, bars, pencils, and other articles and apparatus therefor." R. WERDERMANN. Dated January 22.

ABSTRACTS OF PUBLISHED SPECIFICATIONS, 1880.

1826. "Apparatus for producing electric light." JAMES EDWARD HENRY GORDON. Dated May 4th. Describes the lamp illustrated in the number of the TELEGRAPHIC JOURNAL for Dec. 1st, 1880.

1907. "Railway signal apparatus." WILLIAM ROBERT SYKES. Dated May 10th. 6d. Has reference to improved mechanical and electrical arrangements for carrying out a combined lock and block system of signalling or working signals.

2183. "Railway signalling apparatus." CHARLES ERNESTO SPAGNOLETTI. Dated May 28th. 6d. This invention has for its object improvements in controlling and working trains on railways by locking signals, and interlocking them with the block telegraph system by electrical and mechanical means, the trains in their course assisting in the completion of the system. (*See* page 43.)

2354. "Batteries for the transmission of sound." ROBERT HENELADE COURTENAY. Dated June 10th. 2d. Has for its object the construction of either a single cell or a series of batteries in such a way as to form either a single or compound transmitter of sound by means of a tension spring adjusted to the negative element of the battery. (*Provisional only.*)

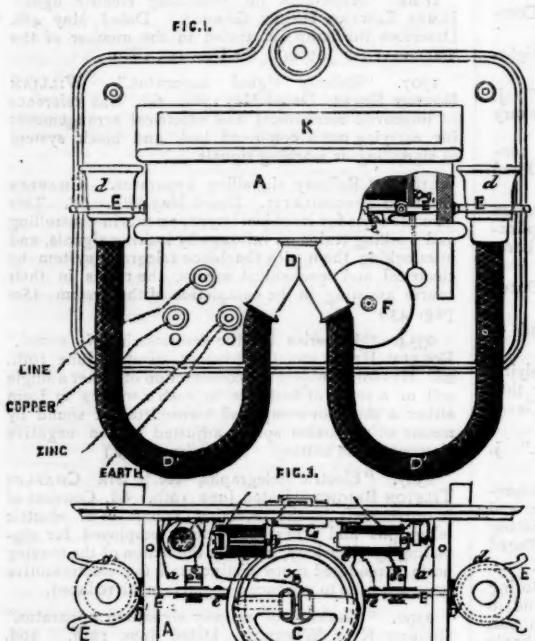
2387. "Electric telegraphs, &c." SIR CHARLES TILSTON BRIGHT. Dated June 12th. 6d. Consists of improvements in the receiving apparatus of electric telegraphs and other instruments employed for signalling by electricity, whereby the action of the moving parts is rendered more distinct and the electromotive force requisite to produce a signal is much reduced.

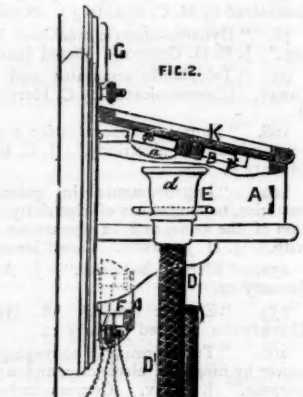
2390. "Working of railway signalling apparatus." GEORGE KIFT WINTER. Dated June 12th. 10d. Relates to improvements in and connected with the working of railway signalling apparatus, has especial reference to improvements in block telegraph instruments which require the combined action of the signalmen at the ends of a section in order that the indications of the instruments may be varied, so that no signal is complete until it has been acknowledged, the combined action of the signal itself and its acknowledgment being required to cause the instrument to indicate the signal that has passed, and in which the state of the line is clearly indicated, not only as to whether there is a train on the section or not, but also the direction in which a train is travelling over the section; and a modification of which allows of either signalman causing both instruments to indicate "train on line," *i.e.*, the "danger" signal, but requires the combined action of both signalmen to remove the "danger" signal and cause the instruments to indicate "line clear." The invention also has reference to the connection of a

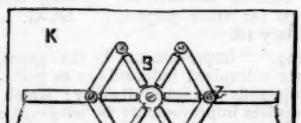
starting-semaphore with the block instruments and with an attachment to the permanent-way in such a manner as that it is put to "danger" by the passage of a train into the block section between such instruments, and can only be lowered by the combined action of the signalmen at the ends of that section.

2453. "Electric apparatus for working railway brakes." JOHN CLAYTON MEWBURN. (A communication from abroad by Ferdinand Auguste Achard, of Paris.) Dated June 17th. 6d. Relates to electric apparatus for working railway brakes, and more particularly to improvements in the apparatus described in the TELEGRAPHIC JOURNAL for August 15th, 1878.

2610. "Telephones. JOHN HENRY JOHNSON. (A communication from abroad from F. A. Gower of Paris.) Dated June 26th. 6d. Relates to the combination of what is known as the Gower telephone with a microphone enclosed in the same case. Fig. 1 is a front elevation of the improved apparatus, a part of the front of the box being removed in order to show the position of the commutator. In this figure it will be observed that the commutator is not in contact with the binding post. Fig. 2 is a side elevation of the apparatus, partly in section, a portion of the side of the box being removed in order to show the communication between the microphone and the principal circuit. Fig. 3 is a plan, the microphone being removed in order to show clearly the arrangement of all the parts on the interior of the box. Fig. 4 is a plan of the underside of the microphone shown in fig. 2. This microphone is connected with the principal circuit by means of wires, a, a^1, which are broken off in figs. 3 and 4. When the plate of the microphone is in the position shown in fig. 2 so as to close the box, the wire, a, fig. 4, is joined to the wire, a, fig. 3, and the wire, a^1, fig. 4, is joined to the wire, a^1, fig. 3. A microphone, B, of any suitable construction (but by preference having at least six contact points, b) is attached to the upper part, K, of a box, A, the lower part of which box is provided with a Gower telephone, C, constructed in the form known as the chronometer telephone. This telephone is provided with a bifurcated acoustic or speaking tube, D, having two branches, D^1, in order to enable the operator to listen with both ears if required. Commutators E are provided at the side of the box for the purpose of interrupting the passage of the current from the battery and opening the circuit of the call bells. After working the apparatus the extremities, d, of the acoustic tubes, D, D^1, are placed in holders connected with the commutators, E, and the circuit is thereby interrupted, as shown in fig. 1, in which figure the commutator, E, is shown out of contact with the binding post, e. An electric call bell, F, is provided underneath the box, A, and a knob, G, for working the call bells is placed at the upper part of the apparatus. An induction coil, H, is placed inside the box, and the microphone, B, and the battery are connected to the







primary circuit, whilst the Gower telephone and the line are connected with the secondary circuit.

Claims.—1st. The combination with a magnetic telephone of a microphone, the two instruments forming constituent parts of one and the same apparatus, substantially as hereinbefore described and illustrated in the accompanying drawings. 2nd. The employment in the said combination of a flexible double tube for speaking and listening, substantially as hereinbefore described and illustrated in the accompanying drawings.

City Notes.

Old Broad Street, January 28th, 1881.

THE ANGLO-AMERICAN TELEGRAPH COMPANY, LIMITED.—An extraordinary meeting of the members of this Company was held on the 14th inst. at the City Terminus Hotel, Cannon Street, "to consider and, if so determined, to confirm and adopt certain agreements made between this Company, the Direct United States Cable Company, Limited, and La Compagnie Française du Télégraphe de Paris à New York, with respect to the working of the lines of the said Companies, and division and appropriation of the traffic receipts." By these agreements, which it was proposed to ratify, the traffic receipts of the three Companies would become divisible in the following proportions:—63 per cent. to this Company, 21 per cent. to the Direct United States Cable Company, and 16 per cent. to the French Company, with certain modifications in the event of interruption of the respective cables. The resolution approving of the agreements having been moved by the chairman, Viscount Monck, and seconded by Sir D. Gooch, M.P., was, after some discussion, put to the meeting, and was carried with two dissentients.

DIRECT UNITED STATES CABLE COMPANY, LIMITED.—An extraordinary general meeting of this Company was held on the 14th inst. at the City Terminus Hotel, "to consider, and if approved, to confirm and adopt certain agreements made between the Anglo-American Telegraph Company, Limited, the direct United States Cable Company, Limited, and La Compagnie Française du Télégraphe de Paris à New York, with respect to the working of the lines of the said Companies, and the division and appropriation of the traffic receipts." Mr. W. Ford presided, in the absence of Mr. Pender, M.P., through the death by scarlet fever of his second son. The solicitor of the Company read the agreements, four in number. By these agreements, taken in connection with the existing agreements between the Anglo-American Telegraph Company and this Company, the joint receipts of the three Companies will become divisible in the following proportions:—63 per cent. to the Anglo Company, 21 per cent. to the Direct Company, and 16 per cent. to the French Company, with certain modifications in the event of interruption of their respective cables. The chairman, after some remarks, concluded by moving a resolution to carry out the objects of the meeting. Mr. Underdown seconded the motion, which, after a short discussion, and a reply from the chairman, was carried unanimously. A vote of thanks to the chairman, and of sympathy with Mr. Pender in his bereavement, closed the proceedings.

The Board of this Company have resolved upon the payment of an interim dividend of 5s. per share, being at the rate of 5 per cent. per annum for the quarter ended 31st December, 1880, such dividend to be payable on and after the 16th February next.

THE CUBA SUBMARINE TELEGRAPH COMPANY, LIMITED.—At the nineteenth ordinary general meeting of this Company, held on the 19th inst., the chairman, Mr. T. Hughes, in moving the adoption of the report and accounts (see THE TELEGRAPHIC JOURNAL of January 15th), said the shareholders would, of course, have seen, with the same regret as the board, that the past half-year had been one of the worst, if not the worst, that the Company had experienced in the ten years of its existence, and from the documents which had been submitted to them they would have no difficulty in accounting for this state of things. They would have seen that practically during the greater part of the year the majority of the sections of the West India and Panama Company's lines had not been working, and they were the best feeders of this Company, and the source upon which they almost relied for their traffic. When such a condition of things as that prevailed, the result must be prejudicial to the Company. He was happy to say, however, that towards the end of the year, by the exertions of the West India and Panama Company, their lines, with two exceptions, were now in working order, the result being at once apparent, because their private advices showed that the traffic was already to a considerable extent righting itself. He regretted, however, to say that the two sections which remained to be repaired of the West India Company's system were two of the most important, namely, the Demerara section and the Colon section, through the latter of which the traffic from the isthmus came to Europe. This section was of increasing importance at the present time, on account of the expedition which M. Lesseps was just about to despatch to the isthmus. After some further remarks the motion was seconded and carried unanimously.

The chairman then moved the payment on the 20th inst. of dividends at the rate of 5 per cent. per annum on the ordinary shares and at the rate of 10 per cent. per annum on the preference shares; this having been seconded was unanimously carried. The meeting then closed with the usual vote of thanks.

THE EASTERN TELEGRAPH COMPANY, LIMITED.—The report of the directors to the seventeenth half-yearly ordinary general meeting, held yesterday (the 27th January), stated that the accounts and balance-sheet for the six months ended 30th September, 1880, show the Company's revenue for this period amounted to £268,128 15s. 5d., from which is deducted £68,039 12s. 4d. for the ordinary expenses of the Company, and £30,476 7s. 2d. for expenditure relating to repairs of cables during the half-year, as shown in the annexed accounts, which, with £3,276 5s. 6d. for income tax, leaves a balance of £166,336 10s. 5d. From this amount, £43,081 2s. 4d., the interest on debentures and the dividend on the 6 per cent. preference shares to the 30th September, 1880, together with two interim dividends on the ordinary shares for the quarters ending 30th June and 30th September, 1880, amounting together to £137,906 2s. 4d., have been paid, leaving a balance of £28,430 8s. 1d. to be carried forward. The several sections of the Company's cables are in good working order, with the exception of the Direct Lisbon Cable, laid in 1870. This cable has been a source of great expense to the Company, owing to very frequent breakages caused by the great irregularity of the bottom of the ocean. In 1876 a break occurred in 2,000 fathoms water, and pending a favourable opportunity for effecting repairs at this depth, arrangements were made for an alternative land line through Portugal, connected by a short cable with Vigo. As, however, the land line and also the Company's duplicate cable between Vigo and Lisbon were interrupted every winter, endeavours were made last summer to restore the direct cable,

and change the position of the Vigo-Lisbon cable. Both of these operations were successfully accomplished. The directors regret, however, to report the breaking of the direct cable within three months after it was repaired; but as the interruption has occurred in a portion of the new cable so recently laid, no doubt is entertained of the restoration of the line by the Company's repairing ship *Chiltern* early next summer. The revenue above mentioned includes the dividends for the half-year in respect of the Eastern and South African line, which is worked by this Company, and in which the Company hold nearly all the shares. The Eastern and South African Telegraph Company, after paying all working expenses and charges for debenture interest and sinking fund, have paid a dividend of 9s. per share (£10) for the nine months ending 30th September last (the period since the line was opened for traffic), being at the rate of 6 per cent. per annum, placing £2,500 to a reserve fund for maintenance ship and hulk, and £25,000 to a general reserve and renewal fund, and carrying forward a balance of £5,124 0s. 7d.

Mr. J. Pender, having moved the adoption of the report, the same having been seconded, in reply to questions alluded with satisfaction to the existing state of affairs as to the Eastern and South African Telegraph Company and the arrangements they made respecting it. If their policy were followed, he hoped that that undertaking would some day be an appendage of the Eastern Company without having cost them very much. There had been a considerable advance in the value of their property since the picking up of the Direct Lisbon cable under the circumstances referred to. There was no doubt that with increased trade in Egypt their revenue as regarded that country would also increase. On the authority of Sir James Anderson they considered that the new cable had been broken just upon the edge of the bank where the water deepened suddenly, and that the part of the cable that was new would be repaired inexpensively. The breakage was through no defect in the cable. He thought that a permanent 5 per cent., with the prospect of a bonus, was better than a fluctuating dividend. Their reserve fund was £300,000, as against a capital expended of £5,000,000. If they had £500,000 at the credit of reserve fund they could replace any of their cables without going to the public for money. The motion was unanimously adopted.

THE directors of the Globe Telegraph and Trust Company announce an interim dividend of 3s. per share on the preference shares, and of 1s. 6d. per share on the ordinary shares.

THE Submarine Telegraph Company have removed their offices to No. 2, Throgmorton Avenue, London Wall.

THE Eastern and South African Telegraph Company, Limited, announce the restoration of telegraphic communication with Cape Colony, Orange Free State, and Griqualand West.

THE superintendent in England of the "Compagnie Française du Télégraphe de Paris à New York" informs us, under date the 17th inst., that the fault in their Brest-St. Pierre cable has been removed, communication to America by this Company's line being thus restored. The vessel which effected restoration, the s.s. *Pouyer Quertier*, left Havre on the 11th inst., and the repair was completed on the 16th. This promptitude on the part of Mr. Dieselhorst and his staff stands out in striking contrast to the failure to repair the Brest cable of the Anglo Company, mentioned on p. 15 in our issue of the 1st of January.

WITH reference to the reports of new Atlantic cable competition, we may state that Mr. Jay Gould has contracted for the manufacture of two cables, and that they are already being constructed by Messrs. Siemens Brothers & Co., Limited. Last week it was reported that Mr. Jay Gould has arrived in London; this was, and is still, we believe, incorrect.

The following are the final quotations of telegraphs for Jan. 28th:—Anglo-American, Limited, 60-60½; Ditto, Preferred, 88-89; Ditto, Deferred, 32-32½; Black Sea, Limited, ——; Brazilian Submarine, Limited, 9½-10½; Cuba, Limited, 8½-9½; Cuba, Limited, 10 per cent. Preference, 16½-17½; Direct Spanish, Limited, 2½-3½; Direct Spanish, 10 per cent. Preference, 12½-12¾; Direct United States Cable, Limited, 1877, 10¾-11½; Scrip of Debentures, 101-103; Eastern, Limited, 9½-9¾; Eastern 6 per cent. Preference, 12½-12¾; Eastern, 6 per cent. Debentures, repayable October, 1883, 102-106; Eastern 5 per cent. Debentures, repayable August, 1887, 102-105; Eastern, 5 per cent., repayable Aug., 1899, 104-107; Eastern Extension, Australasian and China, Limited, 10½-10¾; Eastern Extension, 6 per cent. Debenture, repayable February, 1891, 110-113; 5 per cent. Australian Gov. Subsidy Deb. Scrip, 1900, 104-106; Ditto, registered, repayable 1900, 104-106; Ditto, 5 per cent. Debenture, 1890, 102-104; Eastern and South African, Limited, 5 per cent. Mortgage Debentures, redeemable 1900, 101-103; Ditto, ditto, to bearer, 101-103; German Union Telegraph and Trust, 9¾-10½; Globe Telegraph and Trust, Limited, 6¾-6¾; Globe, 6 per cent. Preference, 11¾-12½; Great Northern, 11-11½; Indo-European, Limited, 26-27; London Platino-Brazilian, Limited, 5¾-6½; Mediterranean Extension, Limited, 2½-3; Mediterranean Extension, 8 per cent. Preference, 10½-11; Reuter's Limited, 10¾-11¼; Submarine, 265-270; Submarine Scrip, 2½-2¾; West Coast of America, Limited, 4-4½; West India and Panama, Limited, 1⅞-1⅞; Ditto, 6 per cent. First Preference, 6½-7; Ditto, ditto, Second Preference, 5¾-6¼; Western and Brazilian, Limited, 7¼-8; Ditto, 6 per cent. Debentures "A," 106-110; Ditto, ditto, ditto, "B," 98-101; Western Union of U. S. 7 per cent., 1 Mortgage (Building) Bonds, 120-125; Ditto, 6 per cent. Sterling Bonds, 104-107; Telegraph Construction and Maintenance, Limited, 36-36½; Ditto, 6 per cent. Bonds, 103-106; Ditto, Second Bonus Trust Certificates, 3½-3¾; India Rubber Company, 18½-19; Ditto, 6 per cent. Debenture, 107-109.

TRAFFIC RECEIPTS.

NAME OF COMPANY.	DECEMBER.		INCREASE OR DECREASE.
	1880. £	1879. £	£
Anglo-American.....	*	...	...
Brazilian Submarine...	†18,900	12,624	...
Cuba Submarine	2,300	3,317	Dec. 1,017
Direct Spanish	1,520	1,551	Dec. 31
Direct United States...	*	...	...
Eastern	48,776	45,704	Inc. 3,072
Eastern Extension	28,010	26,025	Inc. 1,985
Great Northern	16,800	16,936	Inc. 136
Indo-European	...	...	...
Submarine	*	...	...
West Coast America ...	...	...	...
Western and Brazilian	13,038	11,496	Inc. 1,542
West India	...	...	...

* Publication temporarily suspended.
† Five weeks 1880 compared with four weeks in 1879.